VOLUME XXVIII NUMBER 4 WHOLE NUMBER 233

THE JOURNAL

OF

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

DEVOTED TO THE ADVANCEMENT OF ASTRONOMY AND ALLIED SCIENCES

EDITOR
C. A. CHANT
University of Toronto, Toronto.

ASSOCIATE EDITORS

J. S. PLASKETT
Director of the Dominion Astrophysical Observatory, Victoria, B.C.

J. PATTERSON
Director of the Meteorological Service of Canada, Toronto

R. MELDRUM STEWART
Director of the Dominion Observatory, Ottawa

PUBLISHED MONTHLY
(*Ten numbers per year*)

April, 1934

PRINTED FOR THE SOCIETY
TORONTO: 198 COLLEGE ST.

THE JOURNAL

OF

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

VOL. XXVIII, No. 4 APRIL, 1934 WHOLE No. 233

Articles PAGE

Iridescent Clouds and Cosmic Dust (with Plate V) ..... *Frederick Slocum* 145

Radio Talks over CFCT (Victoria, B.C.)—61. Rainbows and Moonbows; 62. Atmospheric Phenomena; 63. The Light of the Night Sky; 64. Small Planets ..... *W. E. Harper* 149

The Texas Observers ..... *P. M. Millman* 161

The Fifty-first Meeting of the American Astronomical Society .... *P. M. Millman* 165

The University of Toronto and the Royal Astronomical Society of Canada ..... *C. A. Chant* 169

Spectroscopic Notes ..... *W. E. Harper* 172

Meteor News

The Alberta Fireball of March 18, 1934—Observations of the 1933 Leonids, Part II ..... *P. M. M.* 175

Review of Publications

The Infra-red Spectrum of the Sun (by Dr. W. Baumann and Dr. R. Mecke) ..... *R. K. Y.* 180

Notes and Queries

Solar and Lunar Halos ..... *C. A. C.* 181

Meetings of the Society

Note by Editor—At Toronto—At Victoria—At Winnipeg—At Vancouver—At London—At Hamilton 183

Upon request, made previous to publication of article, contributors will be supplied free either with fifty copies of the issue containing the article, or with the sheets containing the article attached to a printed cover. If separate reprints are desired the cost will be as follows:

	4 pp.	8 pp.	12 pp.	16 pp.	20 pp.	24 pp.
50 copies	$3 50	$5 50	$ 9 50	$10 00	$13 00	$16 00
100 copies	4 00	7 00	10 00	11 00	14 00	18 00
200 copies	4 50	8 00	11 00	12 00	15 50	20 00

Covers, extra, 50 copies, $1.50; 100 copies, $2.00; 200 copies, $2.50.

Business correspondence, remittances, etc., should be addresed to J. H. Horning, Treasurer of the Society, 198 College Street, Toronto.

Communications regarding Library matters should be addressed to the Librarian.

$2.00 per annum. Single numbers, 25 cents.

Subscription to the JOURNAL is included in membership fee.

FOR SALE. At a nominal price, an observatory dome of first quality, lined with wood and covered with copper. Diameter of curved track about 20½ feet. Enquire of the Editor of this JOURNAL, University of Toronto.

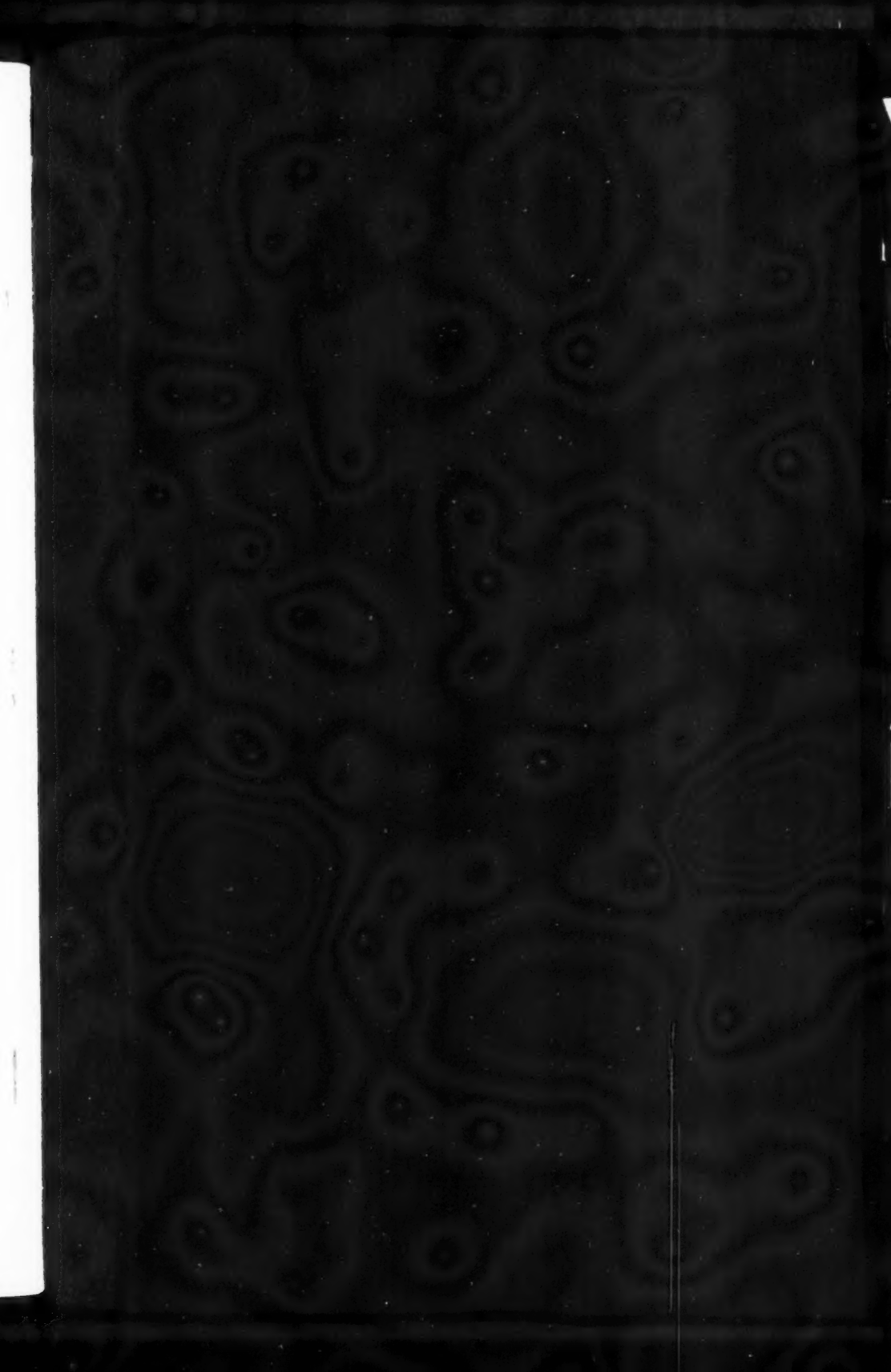


PLATE V.

IRIDESCENT CLOUDS

Clouds photographed from the Yerkes Observatory during the passage of the earth through the tail of Halley's Comet, May 19, 1910. (Photo by F. Slocum)

THE JOURNAL
OF
THE ROYAL ASTRONOMICAL SOCIETY
OF CANADA

Vol. XXVIII, No. 4 APRIL, 1934 Whole No. 233

IRIDESCENT CLOUDS AND COSMIC DUST

By Frederick Slocum

(With Plate V)

THIS note was suggested by several references to mother-of-pearl clouds, in this JOURNAL and other publications.[1] That these are rather rare is indicated by a quotation from Professor Störmer of Oslo. On December 30, 1926, he wrote, "It is surprising to see once more these iridescent clouds. They remain unforgettable in my memory from my school days, when, at the beginning of the nineties, I had the luck to observe these beautiful clouds. Ever since then I have searched the skies to get another view of them, but this winter for the first time I have seen them again."

Like Professor Störmer, I too have been watching the skies since the early nineties, and I have seen one, and only one, display of this type. I made some notes at the time and took a photograph of the clouds. That was over twenty years ago. The observations were not published, but I believe that they may have some astronomical significance and it now seems worth while to put them on record.

A portion of the record in the note book under date of May 19, 1910, reads, "Between noon and 1 p.m. solar halos were observed and also streaks and patches of brilliant colours; some resembling fragments of a rainbow, others isolated bands and patches of iridescence or of monochromatic colours; rose-pink, green, blue, etc. These colours were sometimes apparently projected against cirrus clouds and sometimes against what appeared to be clear sky."

[1] *Journal R.A.S.C.*, Vol. 26, p. 437; Vol. 27, p. 305; p. 345.

The iridescent clouds were at an altitude of from 15° to 20° above the south point of the horizon, the sun at the same time having an altitude of 65°.

Plate V is from a photograph of the clouds made with a 4 x 5 kodak, yellow filter, and Iso plate. The camera was on the roof of the Yerkes Observatory pointing directly south across Lake Geneva. The exposure was made at 12.10 p.m., Central Standard time.

The cumulus clouds shown in the print were drifting slowly from the west. The background is of delicate cirrus, resembling brush marks on an artist's canvas. The horizontal band extending from *A*, at the right edge, nearly half across the plate and 0.8 inch from the top, was coloured like a piece of rainbow, but, unlike a rainbow, it was not an arc of a circle, nor was it opposite the sun.

The fine bright line under the middle of the horizontal band, one inch from the right edge and one inch from the top, is the remnant of what, to the naked eye, was a brilliant patch of iridescent colours, mostly blues, green and yellow. The filter cut out the shorter waves, so there is only a trace on the photograph. To the right of *C*, 0.6 inch from the left edge and 1.2 inches from the top, above the small dark cloud, was another area of iridescence.

Nearly all the staff of the observatory watched the display for an hour or more, and all agreed that they had never seen anything like it before, and all agreed that it was probably connected in some way with the passage of the earth through the tail of Halley's comet.

On this same date, May 19, U.S. Weather Bureau observers, in various parts of the country, reported solar and lunar halos, Bishop's rings, brilliant sunsets, etc. These reports were tabulated and discussed by Professor Humphreys.[2] I will quote one paragraph from his report. "The halos, coronas, and other phenomena listed above were both widely scattered and, in some respects, distinctly unusual; and their occurrence coincident, as near as can be determined, with the passage of the earth through the tail of the comet, suggests for them a cosmical origin. Still they were far from universal, and besides they have all been seen before when there was no comet to which they could be attributed; and therefore, while

[2] *Publ. Am. Astron. Soc.*, Vol. 2, p. 38.

admitting the possibility, in this case, of a cometary influence it would seem rash, without additional evidence, to conclude that the comet was the principal or even the partial cause of any of the appearances mentioned above."

The theory of rainbows and halos has been pretty well worked out on the assumption that they are due respectively to drops of water and to ice crystals. In both cases the results are definite geometrical forms, circles, arcs of circles, nodes of bright circles, etc., but the iridescent clouds appear in irregular bands and patches. I am using iridescent cloud here in the sense in which Störmer used it in the quotation which I gave, that is, as synonymous with mother-of-pearl cloud. The term iridescent cloud has been used by other writers, and also by Störmer himself, in quite a different sense, applying to clouds near the sun with iridescent fringes.

Professor Störmer has recently measured the heights of mother-of-pearl clouds and also of luminous night clouds and has obtained results ranging from about 30 km. to 90 km. This is, of course, high up in the stratosphere where no water vapour or ice crystals would be expected, hence the inference that the iridescence may be due to diffraction of sunlight passing through a cloud of dust, possibly of cosmic origin.

For solar diffraction phenomena produced by a cloud of tiny spheres or circular discs, Humphreys[3] gives the formula:

$$\sin \theta = (n + .22)\frac{\lambda}{2a},$$

where θ is the angular distance from the sun to the diffraction minimum, n the order of the minimum, λ the wave length, and a the radius of the particles. If this holds for the iridescent clouds, then with $\vartheta = 50°$, $n = 1$, and $\lambda = 4500$, since the blues and greens predominate, $2a = .0007$ mm.

On particles of this size radiation pressure exceeds solar gravitational attraction, so it does not seem inconsistent to assume that the brilliant display of May 19, 1910, may have been caused by cosmic dust from the tail of the comet.

Other displays have been seen when there was no known comet around. It is possible that, just as the earth in its orbit is con-

[3]Humphreys' *Physics of the Air*, p. 536.

stantly meeting meteors, so it may occasionally, but very rarely, encounter a cloud of cosmic dust under just the right conditions to produce the iridescent diffraction effects.

Van Vleck Observatory,
Middletown, Conn.,
January, 1934.

RADIO TALKS OVER CFCT (VICTORIA, B.C.)

By W. E. Harper

61. Rainbows and Moonbows

(December 20, 1932)

MY seven minutes this evening will be utilized in calling attention to two very simple phenomena of nature which may not be clearly understood by all of my radio audience. And first of all let us deal with

Rainbows

From the earliest times these beautiful displays of colour have brought pleasure to the beholder. In the book of Genesis we have the account of how, following the Deluge, the rainbow was to be Jehovah's symbol in the heavens of His covenant with the earth to the effect that never again would it be destroyed by flood. Other phenomena of nature might prove alarming to primitive man; the rainbow never did.

Rainbows are seen when sunlight falls on a shower of rain drops in the quarter of the sky directly opposite to where the sun itself is at the time. If the sun is in the east the rainbow will appear in the west and vice versa. A straight line from the sun passing through the observer and produced would indicate the centre of the rainbow arch. Naturally, the lower the sun is, the higher in the sky will be the arch. The maximum arc is thus seen at sunrise or sunset when the centre of the arch lies on the horizon opposite the sun. Half the circumference is then seen.

Without a blackboard or diagrams it is somewhat difficult to explain how the colours are produced. I have, however, in earlier talks explained how light is bent when it passes from air into some denser material like glass or water. Imagine, then, a ray of light from the western sun falling on one of the shower of rain drops in the eastern sky. The drops are roughly spherical. As the ray enters the drop it is bent in accordance with the laws of denser media already outlined. When it reaches the rear or eastern

surface of the drop, part of it passes out but part is reflected back in a different direction to the entering ray. This reflected portion emerges from the western surface, bending slightly once more as it does so. Since violet rays are bent more than red ones the composite white light which entered the drop emerges as a coloured band.

The primary bow then consists of rays that have in the drop been bent or refracted twice and reflected once. In this bow the colours are—inside, violet; outside, red (ivor). In addition to the primary bow there is usually a secondary one in which the rays suffer two refractions and two reflections; in consequence of which extra reflection the colours are seen reversed, *i.e.*, the red is on the inside. This secondary bow is seen above the main one. In exceptional cases several other bows may be seen as well.

The size of the rainbow arc is fixed rigidly by the laws of optics. If we think of lines from the observer's eye to all points of the arc, such would mark out the surface of a cone whose angle must always be 42 degrees. That is to say, if the sun is setting, the axis of the cone will lie parallel with the horizon and the highest point of the arch will be 42 degrees. If the sun should be higher up in the sky the arch will be correspondingly lower on the horizon. After the sun attains an altitude of 42 degrees no rainbow can be seen; it will all lie below the horizon and that is why in summer time rainbows are never seen in the middle of the day.

No two persons see the same rainbow. As the observer shifts his position, so also does the rainbow shift its position, its axis always being in the line of the observer's eye and the sun. The distance away of the raindrops is not material; they may be several miles or only a few yards distant. We can see a rainbow in the spray from a watering can or the nozzle of a hose quite as well as across a stretch of country.

Special forms of the rainbow can be seen on dewy grass lands where the rays from the rising sun make the same beautiful pattern on the landscape as in the sky. Moreover, if the sun is nearly vertically above and one is in the midst of spray as can be experienced by passengers aboard the little steamer "Maid of the Mist" which goes almost up to the foot of Niagara Falls, then the rainbow makes a complete circle surrounding the vessel.

Sometimes the intensity of the rainbow is much greater than at others. I have not looked up the mathematics of why such is the case but offhand I would think the brilliancy, other things being equal, would depend on the number and size of drops. Their uniformity of size would moreover tend to uniformity of direction and a crisp, well-defined arc would be observed.

In some literary works the statement has been made of cases where people have driven right through the arch of the rainbow. Such is impossible; the rainbow is always and ever unapproachable. Certain lines from Tennyson's *Ulysses* might be wrenched from their proper setting to suggest the elusiveness of the rainbow.

> ....."an arch wherethro'
> Gleams that untravell'd world, whose margin fades
> For ever and for ever as I move."

We have all heard of the proverbial pot of gold buried at the base of the rainbow. As we each see our own rainbow then must there be a pot of gold for each of us but alas as we move towards it, it likewise recedes from us.

A certain amount of weather lore is connected with the rainbow. Who has not heard the familiar rhyme in childhood

> "Rainbow at night is the sailor's delight
> Rainbow in the morning is the sailor's warning."

I should not wish to discredit entirely the value of such weather lore which undoubtedly has grown up through observations from generation to generation. There is, moreover, an element of probability in this particular one for this reason. Taking the earth as a whole the weather seems to move from west to east. Hence a rainbow in the morning, when the bow would appear in the west, would imply showery conditions in that quarter which in general would move eastward. On the other hand, the rainbow at night would imply that the showery conditions were to the eastward and had passed away from us.

Moonbow

The corresponding phenomenon of moonbow has an identical explanation but it is more rarely seen as it is only at or near the times of full moon that the moon's light is sufficiently strong to

produce the coloured arc. Like the rainbow the moonbow will have a radius of 42 degrees and will appear in the quarter of the sky opposite to that occupied by the moon. As the full moon rides higher in the heavens in winter than in summer the moonbows will in general be lower on the horizon in winter than in summer. I have noted them a few times of recent years and had my attention drawn to them by others who were unaware that such were possible until they had actually observed them.

62. Atmospheric Phenomena

(January 17, 1933)

I purpose tonight giving brief explanations of a few atmospheric phenomena that everyone has observed, but for which the explanation may not be at first apparent.

The first one of these is the blue of the sky. From infancy we have accepted it as blue, possibly without enquiring the reason. Why is it blue in preference to any other colour, particularly to yellow, the colour of the sun? It comes from the scattering of the blue of the sunlight by particles in our atmosphere. Our atmosphere contains impurities such as little dust particles on which at times droplets of water vapour are condensed. While sunlight includes all the rainbow colours from red to violet the blues and violets are much the shortest in wave-length and in consequence are the ones which are most scattered or diffused by the extremely minute particles met with. Thus the prevailing colour is blue although towards the horizon it becomes grayish. If we were to ascend to great altitudes, the zenith would deepen from blue into violet. If there were no atmosphere to the earth at all, the sky would appear perfectly black. At sunrise or sunset the rays of light are coming to us directly through a layer of atmosphere near the earth's surface which is unusually dense. The shorter blue and violet rays find it more difficult than their longer red and yellow confreres to wiggle through the obstructions and are eventually absorbed. The longer red rays do get through and in consequence we have the rosy dawn and the crimson sunset.

At certain times there is an unduly large number of dust particles in the atmosphere. Volcanic eruptions pour out vast quantities of fine dust. If such eruptions are of the explosive variety like

Krakatoa in 1883 or Mount Pelee in 1904 or Katmai in 1912, then it is possible the particles may reach the region of the stratosphere, above the cloud and storm layer. They may remain a year or so there before gravitation brings them into the lower layers where rains wash them down to earth. And just as the smoke from forest fires reddens sunlight, so such volcanic dust often for a considerable period causes lurid sunsets and tinges the blue of the sky with a rosy glow.

But even apart from volcanic ash the air molecules and large droplets of water vapour will redden the sky in the neighbourhood of the rising or setting sun. The vapour condenses around a particle as a nucleus; it grows larger if the atmosphere is saturated and eventually is precipitated as rain. It is interesting to note that weather lore connected with this phenomenon, and dating back to the beginning of the Christian era is now considered to have scientific grounds for its basis. In *Matthew 16*, verses 2 and 3 we have: "When it is evening, ye say, It will be fair weather; for the sky is red. And in the morning, It will be foul weather today; for the sky is red and lowering."

Professor Barnes of McGill, who in his researches on the formation of anchor ice has had occasion to study the colour of the light at sunrise from photographs made on specially sensitized plates gives the explanation. At sunrise a red sky indicates the presence of great water particles, which readily come together into rain drops by the sunlight and, hence, a red sky in the morning indicates rain. If the sky be red in the evening, it indicates that the water vapour is in drops below the rain-drop size and such during the dark hours of the night will be deposited as dew.

Since I have quoted a verse from the New Testament, I shall balance it with a beautiful metaphor from the Old Testament,—In Psalm 119—"If I take the wings of the morning, etc." The "wings of the morning" are undoubtedly the shafts of light that find their way through cloud openings in a broken sky and spread out fan-shaped from the rising sun. A more modern rendering of the same phenomenon ascribes it to "the sun drawing water" and possibly many in infancy believed that the sun was actually sucking up water preparatory to showering Mother Earth.

I pass next to consider what are known as halos around either

the sun or the moon. When the atmosphere is saturated we frequently see the moon surrounded by a halo, a few moon diameters in width. Tennyson in the poem "Margaret" put it thus:

> "Like the tender amber round
> Which the moon about her spreadeth
> Moving through a fleecy night."

Similar halos surround the sun under like conditions but these are not so often noted for the simple reason that we do not look at or near the sun since its light is usually too strong for the unprotected eye. In both these the outer rim is reddish.

In addition to the halo there usually is a complete ring of light at some distance from the luminary, be it the sun or moon. The first outer ring is always distant 22 degrees and is coloured, the red being on the inside. One ring is generally all that is seen around the moon but the stronger light of the sun permits us to see at least another, distant 46 degrees, with a wealth of other detail. Crossing the rings will be another circle parallel to the horizon plane and cutting the sun centrally. At the intersections of this circle with the other two the mock suns are to be found. In special cases much other detail is possible which will not be touched upon here.

The cause of all such circles is the existence in the upper atmosphere of ice crystals whose particular form disperses the light in the required manner to produce the observed effects. It is common knowledge that as we go upwards the air becomes cooler until at the height of the cirrus clouds temperatures much below freezing are attained. Examination of snow flakes under a microscope show that they are hexagonal in form and likewise the ice crystals are either hexagonal disks or hexagonal prisms formed by a great number of these disks being piled on top of one another. The light from the sun passing through such a prism has a number of possible paths and as a result rings of 22° or 46° are formed. The mathematics of the structural detail is quite complicated but it has been fairly well worked up. Indeed certain formations are possible which to date have never been observed and thus it would seem wise, when these phenomena are noticed, to sketch as accurately as possible just what is seen and report the same.

It is a fairly safe prediction that when these phenomena are seen that shortly thereafter precipitation, either as rain in the summer or snow in the winter will occur.

63. The Light of the Night Sky

(February 14, 1933)

After sunset the sun's rays continue to light up the upper air for an interval of time which varies with one's position on the earth and the time of year. This reflected light from the upper atmosphere is spoken of as twilight. At the equator its duration is very short but in our latitude there is considerable in the winter and more in the summer. The sun must be about 18 degrees below the horizon before darkness fully sets in.

When the moon is full its light overshadows all else at night, making it quite impossible to see the faint stars with the naked eye. The planets like Venus, Mars, Jupiter and Saturn also send earthwards a considerable amount of reflected sunlight. My aim is to discuss the light of the night sky when twilight is past and when no moon or planets are to be seen.

Consider such a night, perfectly clear, without moon or planets showing. A casual glance at the sky would suggest that the stars, bright and faint, were scattered somewhat at random. Closer scrutiny, however, would reveal a faint band of light encircling the sky, at this season of the year stretching from northwest to southeast. This, as everybody knows, is the Milky Way and is caused by the suffused glow of faint distant stars.

The stars extend to great distances but the universe is not infinite in extent otherwise every last portion of the hemispherical dome would shine with a great radiance. The Milky Way regions approximate to such a condition for its surface illumination is very much greater than regions of the sky distant from it, in conformity with its ten-fold greater depth.

The numbers of the stars of each magnitude or brightness have been fairly well determined down to effective limits and from such determinations a simple calculation shows that the total light of all the stars is the equivalent of about 500 stars like Vega, the brightest star in the northern sky. It is rather surprising that the stars that are visible to the naked eye make up only one-fifth of this amount; the other four-fifths comes from stars too faint to be seen by the naked eye.

But it is found that the general illumination is much in excess

of what can thus be contributed by the stars themselves. Part of this excess is known to be caused by a general auroral illumination just as if an aurora were present every night. Its supposed connection with the aurora came about through its analyzed light showing the same strong, prominent line in the green (5573) as occurs in aurorae. For a number of years various investigators have carried on researches, some of them on a co-operative basis in which our own observatory has taken a minor part. These seem to indicate that while the auroral illumination fluctuates from time to time such variations do not synchronize with any magnetic changes on the earth. However, there seems to be a correlation over a long period with the sun-spot cycle so that doubtless the same cause can be assigned to these variations as to those of the ordinary Northern Lights which are known to increase in number with increase of sun-spottedness. Much remains to be learned of the short-period fluctuations and this is one of the items on the programme of the expeditions in the north in connection with the International Polar Year. Our observatory is assisting the Meteorological Service of Canada in securing the necessary observations in this locality.

The total light of the stars contributes not more than 20 per cent. to the general illumination of the night sky. Considering that another 20 per cent. is due to this faint auroral glow, where does the other 60 per cent. come from? It is due to the Zodiacal Light which is a band of light something like the Milky Way, but stretching along the ecliptic. It can be seen best in the spring when the ecliptic is nearly perpendicular to the horizon. After twilight has disappeared this band of light can then be seen stretching from the horizon near where the sun set, upwards along the ecliptic. At the horizon it is wider and brighter than the Milky Way, but it grows narrower and fainter at higher altitudes.

This luminous belt can be seen at all seasons of the year, which is to state that it extends right around the ecliptic. Indeed, in the tropics in very clear air at midnight the extremities of the western and eastern bands can actually be seen to meet and where they come together, that is diametrically opposite the sun, there is a slightly brighter patch called the Gegenschein or counterglow.

Spectrum analysis shows the Zodiacal light to be identical with

sunlight and other observations likewise make it almost certain that zodiacal light is sunlight reflected from innumerable small particles. These are scattered throughout a region somewhat lens-shaped, which extends from the sun as a centre out past the earth for a million miles or so.

The fact that the zodiacal light is polarized suggests that these particles are extremely small. They may be small enough to be held off at that distance by the light pressure of the sun's rays; if not, each particle must be independently moving about the sun, just like the planets themselves. In any case, calculation shows that the amount of matter necessary to produce the observed illumination is surprisingly small. Particles one millimetre (1/25 inch) in diameter spaced every five miles each way would do the trick. If the matter is not in the solid but in the gaseous state then the gas if compressed to atmospheric pressure would form a layer less than half an inch thick. Naturally so rarefied a medium would not sensibly retard the motion of the planets through it.

To summarize and conclude. The general illumination of the night sky is 20% from the stars, 20% from an auroral glow and 60% from sunlight reflected from extremely small particles in the plane of the ecliptic.

64. Small Planets

(March 21, 1933)

My last address dealt in part with finely divided matter in the solar system, extending from the sun out beyond the earth. Sunlight reflected from these particles explains the so-called zodiacal light, the main contributing factor in the light of the night sky. It it unknown whether such particles are of sufficient size for gravity to act upon them; if so, then each particle must be pursuing its own path of revolution about the sun.

While uncertainty exists upon their orbital motion we have an analogous phenomenon in the host of little planets which, much farther out from the sun, are nevertheless in motion about the central luminary. The main planets revolving about the sun are Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune and Pluto. These are spaced at increasing distances from the sun but between Mars and Jupiter a big gap occurs. From a certain

symmetry in the way the earliest known planets were spaced, it was felt that there should not be this gap but that a planet should be found there. It is in this gap that these small planets are found.

Beginning on the first night of the nineteenth century (January 1, 1801) when a faint object was discovered whose motion among the stars indicated that it was a planet, there has been a steady increase in the number of these small planets known to exist. No less than 200 were discovered in 1931, but many of these yearly numerous discoveries are later found to be identical with previous ones. The total number which have been accepted as genuine and have had their orbits determined is barely over 1200. Sometimes they are spoken of as asteroids from their similarity to a star (Gr. *aster*; Lat. *astra*) in showing no appreciable disk.

The main planets revolve about the sun approximately in one common plane which we call the ecliptic plane. While the asteroids do not hug this plane as tenaciously as the larger planets, they nevertheless do not depart greatly from it and hence those who are searching for new ones confine themselves largely to this narrow belt in the sky. The earlier discoveries were made by comparing the stars seen in the field of a telescope with the chart of known stars. If there should be an apparent interloper it was examined carefully and if after a few hours it showed motion with respect to the others, then it could be rightly concluded that it was a minor planet. Such a process was very laborious and after the brightest of these bodies had been picked up in this way, enthusiasm in the work began to wane.

It was then that the photographic method of discovery was developed by Wolff of Germany. His method was simply to photograph these likely regions of the sky, keeping the telescope always pointed at the same region. Clock-driven telescopes enable one to do so over several hours and on such plates the real stars appear as circular dots. If there should happen to be an asteroid in the field, its motion relative to the stars would result in its showing on the plate as a streak, not a dot. This improved method speeded up discovery and fainter members of the group were reached. But many of these objects are exceedingly faint and fail to leave any record on the plate when their image is thus spread out in a streak.

To an American amateur astronomer, a clergyman by the name of Metcalf, was due the ingenious suggestion of imparting to the telescope a motion such that it would follow not the stars but one of these asteroids, if such there existed in the region. The plates would then show the stars as streaks, whereas the light of an asteroid would register itself approximately all in one position on the plate. Thus dots on the developed plate would indicate asteroids. This improved method permits one to pick up very faint bodies of this character.

While it was stated above that these minor planets fall between the orbits of Mars and Jupiter there are a few stragglers from the fold. Considering the earth's distance from the sun as unity, then Mars is distant from the sun 1.5 and Jupiter 5.2. Until very recently Eros, at a distance of 1.46, was the only asteroid that came within the orbit of Mars whilst the farthest known one at a distance 5.71 is slightly beyond the orbit of Jupiter. The average distance, however, of the first 800 discovered coincides with the mean distance (2.8) between Mars and Jupiter. While our principal planets move about the sun in orbits that are nearly circular the asteroids have paths which are quite elliptical and, as already stated, they are in some cases markedly inclined to the ecliptic.

It has been mentioned above that Eros is the only one of these whose orbit lies within that of Mars. At times when the earth and this asteroid are on the same side of the sun their distance apart is small and such occasions lend themselves to an accurate determination of the sun's distance. Such a favourable opposition occurred in 1901 and again in 1931 when Eros was extensively observed at many places throughout the world. Its suitability lies not only in the asteroid's relative nearness to us (16,200,000 miles in 1931) but also in the fact that its star-like image makes for accurate determination of its position.

But just about a year ago two more of these asteroids were discovered which come even closer than Eros and which will in the future be even more valuable than it for determining the sun's distance. One was discovered by Delporte of Belgium and ten days after its discovery this planet, which bears his name, was only 10,000,000 miles from us. This was at the middle of last March.

In April another such planet was discovered by Reinmuth at Heidelberg which is even more remarkable. It reached its minimum distance of about 6,000,000 miles from the earth in the middle of May.

None of these bodies are ever visible to the naked eye. Even Eros at its closest approach was much below naked eye visibility. The two objects mentioned above were, at their closest approach, around the 12th or 13th magnitude which means 7 magnitudes too faint for the naked eye. Translated into simpler language, the planet Delporte would have to be 625 times as bright as it is at closest approach to be detected by the naked eye.

Such extreme faintness coupled with relative nearness makes us suspect that these bodies are small in size. Only a few of the largest show an appreciable disk, and measures with the micrometer are very difficult. The largest is considered to have a diameter of 480 miles. We can only infer what the diameters of the small ones are by their brightness relative to the larger ones and in this we assume that they are all composed of the same kind of material. The majority range from 10 to 50 miles in diameter. The two exceptional bodies of Delporte and Reinmuth are in a class by themselves with diameters not over a mile—in fact they are just fair-sized mountains.

Most of these planets when critically observed show variable brightness apart from that due to their changing distance from us. Such has been best explained as due to the bodies rotating and turning towards us portions of their surface which differ in reflecting power. Different classes of rocks differ, you understand, in their reflecting power, similar to the difference between that of white and black surfaces.

Various theories are advanced to account for the origin of these minor planets. One suggestion is that here a planet failed in the making; another that, after formation, it exploded and what we are discovering now are the fragments. The latter theory seems from recent evidence to possess some merit in that there are groups of these asteroids with markedly similar orbits. Unless the discoveries to date represent but a small portion of existing fragments the planet must have been a small one, as it has been computed that the total mass of all the known asteroids does not exceed 1/2000 that of the earth.

THE TEXAS OBSERVERS

By Peter M. Millman

DURING the past decade an ever-increasing interest in serious observational astronomy has been shown by amateurs both in the United States and Canada. There is one group of observers, however, which deserves special mention, both because of the never-failing industry and enthusiasm of its members, and because of the very real scientific value of the results which they have achieved. I refer to the group known as the "Texas Observers", with headquarters at Ft. Worth, Texas.

The "Texas Observers" were first formed early in 1928,—a group of six young men drawn together by their mutual interest in astronomy and their desire to make definite contributions to this science. No officers were elected and no attempt was made at a definite organization, but there was exhibited that spirit of unselfish co-operation and a willingness to work which is more essential to the production of results than is an imposing list of official titles. The original group consisted of Robert Brown, Oscar E. Monnig and Blakeney Sanders, of Ft. Worth, Texas; James H. Logan and Graham D. Kendall of Dallas, Texas, and Sterling Bunch, now of Knoxville, Tenn. More recently Ambrose Burns, H. H. Morse and Sears Roach at Ft. Worth and B. F. Grandstaff at Dallas have actively participated in the observations of the group.

The instrumental equipment first used by the Texas Observers consisted of an 11-inch reflector, a 6-inch reflector and a 3.5-inch refractor, in addition to several smaller photographic lenses. In 1929 the need for an efficient photographic lens was felt and the A.A.V.S.O. loaned them the 5-inch doublet of 24-inch focal length which had formerly been used by C. A. Post. Many excellent photographs have been secured with this, the guiding being done with a 4-inch refractor.

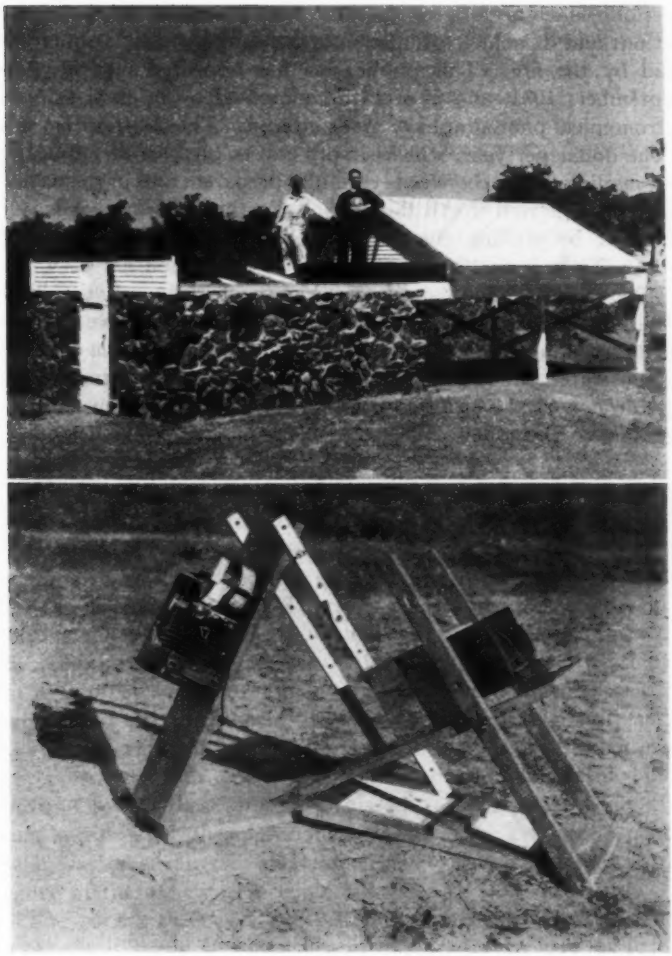
Permanent mountings for the larger instruments were constructed by means of an ingenious adaptation of old Ford parts, and these were set up at a favourable location some 15 miles from

Ft. Worth. Later, at a cost of under one hundred dollars, a small stone building with a sliding roof was built around the mountings (see Fig. 1). The entire planning and work of construction was carried out by the Texas Observers themselves and thus the Estrellas Observatory came into being, the most southern of all the observatories in the United States, with the exception of the Steward Observatory at Tucson.

The activities of the Texas Observers have been many and varied. Bunch, Logan, and Monnig have for a number of years been regular observers for the A.A.V.S.O. The whole group has been very active in meteor observing, as is shown by the reports of the American Meteor Society. These meteor observations have always been carefully planned and whenever possible have been made simultaneously from several stations. Much material for height computation has been obtained in this way. Monnig, as regional director of the American Meteor Society for Texas, has, on several occasions, collected observations of fireballs observed in the neighbourhood and performed the reduction for the computation of real paths.

The photographic programme has included photography of the sun, moon, comets, nebulae, zodiacal light, and meteors. A fast F 3.5 Xenar lens was secured especially for the purpose of meteor photography and continued attempts were made despite initial failures, the result being several very fine meteor photographs. In 1932 prisms were borrowed from the Harvard Observatory and the University of Texas and two meteor spectrographs were constructed. A Leonid spectrum was photographed in November, 1932, and two more spectra were obtained in 1933, one in April and one in August. When it is remembered that up to the present less than 30 meteor spectra in all have been photographed, it is seen that this is a very fine record. It indicates a great deal of conscientious effort. The texas Observers have recently purchased their own meteor spectrograph which promises to be of great efficiency.

The amateur astronomers of Texas, and in fact many in more distant parts of the continent, are kept in touch with each other by the *Texas Observers' Bulletin*, which consists of three or four mimeographed foolscap-size pages and contains notes and dis-



THE TEXAS OBSERVERS

Above—The Estrellas Observatory. Left, Robert Brown; Right, Blakeney Sanders.
Below—The meteor spectrographs.

cussions which are of great interest to any amateur who prefers to get out and do some real observing rather than to sit at home and read by the fire. This publication has appeared monthly since September, 1931, and is often accompanied by original prints of astronomical photographs of great interest. The subscription price is one dollar per year, which simply covers the cost of publication and mailing. The *Bulletin* is carefully prepared, and in the writer's estimation, is well worth the dollar. Further information may be obtained by writing the Texas Observers, 312 W. Leuda, Ft. Worth, Texas.

The writer cannot speak too highly of the work the Texas Observers are doing. They have set a very fine example for other amateurs in both Canada and the United States and have definitely demonstrated the great value of co-operative effort among those who do not mind a little hard work and who are anxious to make lasting contributions to science.

THE FIFTY-FIRST MEETING OF THE AMERICAN ASTRONOMICAL SOCIETY*

By Peter M. Millman

THE winter meeting of the American Astronomical Society was held in Cambridge, Mass., from December 28 to 30, 1933, in connection with the 93rd meeting of the American Association for the Advancement of Science. Historic Boston greeted its many visitors with the largest snowfall in several years and this was followed by two or three days of cold weather which set an all-time low record for the metropolitan area. At the opening exercises of the Association President H. N. Russell remarked that it was just eleven years ago that Boston had treated the American Association for the Advancement of Science in exactly the same manner and, as an astronomer, he couldn't help but think that the sunspots had something to do with it.

The headquarters for the American Astronomical Society and Section D of the American Association were located at the Harvard Observatory by the invitation of Dr. Harlow Shapley, the director. A large and varied program of thirty-nine papers was divided into four sessions scheduled for Thursday afternoon (Dec. 28), Friday morning and afternoon (Dec. 29), and Saturday morning (Dec. 30). The temperature on Friday was so low that fears were entertained lest a fair percentage of the society freeze in their tracks should they venture forth to lunch. Happily, the observatory staff, under the guiding genius of Mrs. Shapley and in their usual efficient manner, prepared, with but two hours' notice, a delightful buffet luncheon for all those present. This was served in the computing room and was greatly appreciated by everyone. The group photograph was taken directly after lunch and, for the first time in the history of the society, was taken indoors.

The papers themselves proved to be an extremely interesting group and it would be impossible in this brief review to do justice to all of them. A few points must be mentioned however. One of

*Crowded out of last issue.—*Editor.*

the most interesting developments was the evidence presented in several papers that the disparity in size between our own galaxy and outside galaxies might not be as great as has hitherto been believed. Dr. J. S. Plaskett presented two papers, by himself and Dr. J. A. Pearce, giving the latest Victoria determination of the distance and direction of the galactic centre. Corrections to Newcomb's precession were determined from the proper motions of a group of B stars, including terms for solar motion and galactic rotation in the equations. Using these corrections the distance to the galactic centre, as determined from the rotational components of the B stars, was 10,000 parsecs in a direction 324°.4 galactic longitude. This agrees with other recent determinations and somewhat reduces former estimates of the size of our own galaxy. On the other hand Dr. Joel Stebbins presented evidence from measures made with the photoelectric cell that the total extent of the Andromeda nebula was much greater than that derived from an examination of the photographs. This had already been suspected after Hubble's discovery of the nebula's globular cluster system. The apparent extent of the nebula is between five and six degrees, which corresponds to an actual diameter of about 100,000 light years. Dr. Shapley reported that, as would be expected, the fast, short-focus patrol cameras of the Harvard Observatory had proved extremely efficient in photographing the outer bounds of the nebulae and that the AI camera with a lens of aperture 1.5 inches had produced a photograph of the Andromeda nebula on which the diameter was between five and six degrees. Microphometer tracings of distant extra-galactic nebulae reveal that the previously measured diameters of these objects are too small. The old values are increased by at least 50 per cent. for the spirals and 100 per cent. for the spheroidal nebulae.

Great interest was shown in the recently discovered method for coating telescope mirrors with aluminum, the chief advantage being the high reflecting power of this element in the near ultra-violet. Dr. S. L. Boothroyd reported that the Cornell expedition to Arizona had been able to photograph the spectra of stars down to 3000 A. with a 15-inch aluminum-coated reflector. Dr. Dunham, of Mt. Wilson Observatory, mentioned that all their mirrors, with the exception of the 60-inch and 100-inch, were now coated with aluminum and were found to be extremely satisfactory in operation.

A paper on the "Electronic Telescope" by Dr. F. C. Henroteau indicated the possible future development of telescopes of an entirely new type. This appeared in the last number of the JOURNAL. Other Canadian papers were by Dr. Helen B. Sawyer on the variable stars in the cluster Messier 2, by Dr. F. S. Hogg on recent interesting changes in the remarkable star Z Andromedae, and by Messrs. W. E. Harper and W. H. Christie on the binary VV Cephei. These three papers were read by Dr. Plaskett.

A most ingenious application of Hollerith Sorting Machines to lengthy astronomical computations was described by Dr. W. J. Eckert. The particular problem being attacked is the determination of a new theory of Vesta. Once the method has been worked out and the equations set up, a new planet epoch can be derived in ten minutes, and in a day the planet can be carried forward several years, taking account of all perturbations. Dr. T. Dunham's recent work on the B-band of oxygen in the spectrum of the earth-shine on the moon makes the presence of oxygen in any measurable quantities in the atmosphere of Mars extremely doubtful. A paper by Dr. E. C. Slipher on the recent white spots on Saturn was accompanied by some excellent photographs of the planet. The rotation period of Saturn, as determined by the 1933 spots, agrees within a fraction of a second with that found by Hall in 1876.

On Thursday afternoon Dr. and Mrs. Shapley held a reception for the society in their residence. Here, in the friendly and informal atmosphere so well known to those who have at any time been connected with the Harvard Observatory, it was most pleasant to greet again old friends from various parts of the continent. The society dinner was held Friday evening at the Faculty Club and this, after the viands customary at such an event had been consumed, developed into an interesting contest where much amateur talent was unexpectedly unearthed among the assembled astronomers. Saturday afternoon there was an opportunity for visiting the new Oak Ridge station of the Harvard Observatory, or Wellesley College and the Whitin Observatory.

Memorial Hall of Harvard University, usually silent except when its echoes are wakened by the fearful scratching of examination pens, was transformed into a scientific museum for the course

of the meetings. Here one could see just how his heart beats, how living cells act when being spun at 10,000 revolutions per minute or what your own voice sounds like over the telephone. Not the least interesting exhibit was a machine which, by means of a photoelectric cell, transfers printed matter to a large aluminum sheet, where it appears in the form of embossed letters that can be read by the blind without the necessity of learning Braille.

The *pièce de resistance* of the program was the combined meeting on Saturday evening of the American Association for the Advancement of Science and the American Academy of Arts and Sciences for the purpose of conferring upon Dr. Shapley the Rumford Medal. Dr. Shapley gave a most interesting address on recent work that had been done at the Harvard Observatory in dissecting the anatomy of the Large Magellanic Cloud. This is now undergoing a most thorough scrutiny by means of star counts, the study of variable stars and globular clusters, and any other means by which it can be made to yield its secrets. It is already evident that the real extent of the cloud must be considered much greater than that assigned to it in the past.

In addition to the regular items on the programme there were opportunities to visit the great museums and places of historic interest in and around Old Boston. I think that, without doubt, everyone returned home feeling that they had spent a most profitable and enjoyable time.

THE UNIVERSITY OF TORONTO AND THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

By C. A. Chant

IN our last issue (p. 122 and fol.) there was given an account of the negotiations between the University of Toronto and the Royal Astronomical Society of Canada regarding the loan of the technical portion of the Society's library to the David Dunlap Observatory.

At a meeting of the Council of the Society on March 29 the letter from the secretary of the Board of Governors of the University, accepting the offer of the Society, was read. It is as follows:

24 February, 1934.

The General Secretary,
Royal Astronomical Society of Canada,
198 College Street,
Toronto, 5.

Dear Sir:—

Your letter, of date the 3rd instant, addressed to President Cody, was laid before the Board of Governors at their meeting on the 22nd instant.

I am directed to inform you that the Board cordially accept the proposal of the Royal Astronomical Society to place on loan with the David Dunlap Observatory the technical portion of the Society's library, as designated in the list appended to your letter, on the terms indicated in your communication.

The Board desire me also to convey to your Society their appreciation of this co-operation with the Observatory in regard to forming a working library for the latter, and their sense of the benefits which will result to all concerned.

Yours very truly,

(Signed) F. A. Mouré

The following is a list of the publications which are to be transferred. Some of the series are not complete and an effort will be made to supply the missing numbers.

List of Publications to be Loaned by the Royal Astronomical Society of Canada to the David Dunlap Observatory

Abbadia Observatory.
Alger Observatory.
Allegheny Observatory.
American Academy of Arts and Sciences.
American Association.
Annuaire astronomique.
Argentine National Observatory.
Astrographic Catalogue.
Astronomical Journal.

Astronomical Register.
Astronomische Mitteilungen.
Astronomische Nachrichten.
Astronomische Rundschau.
Astronomischer Jahresbericht.
Astronomy and Astrophysics.
Astrophysical Journal.
Berlin Academy of Science.
Berliner Astronomisches Jahrbuch.
Berlin-Babelsberg Observatory.
Bordeaux Observatory.
British Association for the Advancement of Science.
British Astronomical Association.
Cambridge Observatory.
Cape of Good Hope, Royal Observatory.
Carnegie Institution of Washington.
Cartuja (Granada) Observatory.
Cincinnati Observatory.
Coelum.
Columbia University Observatory.
Comité international permanent pour la Carte du Ciel.
Dorpat, Observatoire astronomique de l'Université de Tartu.
Dunsink Observatory.
Finnish Geodetic Institute.
Flower Astronomical Observatory.
Franklin Institute.
Gazette astronomique.
Geodetic Survey of South Africa.
Georgetown College Observatory.
Göttingen Observatory.
Hamburg Observatory.
Hamilton College Observatory.
Harvard College Observatory.
Himmelswelt.
Institute de France, Académie des Sciences.
International Boundary Committee.
International Union for Solar Research.
Journal des Observateurs.
Kaiserl. Leop.-Carol. Deutschen Akademie der Naturforscher.
Kiel Observatory.
Klein, Jahrbuch der Astronomie und Geophysik.
Kodaikanal Observatory.
Konigstuhl-Heidelberg Observatory.
Laws Observatory.
Leander McCormick Observatory.
Leavenworth Observatory.
Lehigh University.
Leiden Observatory.
Lick Observatory.
Lisbon Royal Observatory.
Lowell Observatory.
Lund Observatory.
Madras Observatory.
Marseilles Observatory.
Mathematische und Naturwissenschaftliche Mittheilungen.
Meudon Observatory.
Monthly Record.
Monthly Weather Review.
Munich Observatory.
National Academy of Sciences.
National Physical Laboratory. Kew Observatory.
Nice Observatory.
Norman Lockyer Observatory.
Observatoire royal de Belgique.
Observatory.
Paris Observatory.
Pulkova Observatory.
Potsdam Astrophysical Observatory.
Radcliffe Observatory.
Rocznik Astronomiczny Obserwatorjum.
Royal Astronomical Society, London.
R. Instituto di studi superiori . . . in Firenze.
Royal Observatory of Edinburgh.
Royal Observatory, Greenwich.
R. Osservvatorio Astronomico di Brera in Milano.
Royal Society of Canada.
Royal Society of Edinburgh.
Royal Society of London.

Royal Society of Queensland.
Russian Astronomical Journal.
St. Louis Academy of Science.
Sidereal Messenger.
Smithsonian Institution.
Società degli Spettroscopisti Italiani.
Société astronomique de France.
Société Belge d'Astronomie.
Specola Vaticana.
Terrestrial Magnetism and Atmospheric Electricity.
Tokyo Observatory.
Toulouse Observatory.
Union Observatory of South Africa.
U.S. Coast and Geodetic Survey.
U.S. Naval Observatory.
Upsala Observatory.
Utrecht Observatory.
Various meteorological bulletins.
Vassar College Observatory.
Washburn Observatory.
Wisconsin Academy of Sciences.
Yale Observatory.
Yerkes Observatory.
Zurich Observatory.

SPECTROSCOPIC NOTES*

By W. E. Harper

(1) The Cluster Variable H.R. 1615

IN studying the variations in light of the eclipsing binary *zeta* Aurigae whose spectroscopic elements were determined some years ago by the writer, Hopmann used the above star (1900, *R.A.*=4^h 56^m.2, *Decl.* +41° 18′) as one of his comparison stars. In this way he discovered that it also varied in light and further work led him to conclude it was a cluster variable of the RR Lyrae type. The record of his investigation is published in *Zeitschrift für Astrophysik*, Band 6, page 385, and while the star appears under another name the writer noted it as one of his A-type programme.

As the previously known RR Lyrae variables are all faint it was only natural that one as bright as this one, visual magnitude 6.20, should be looked upon as something of a find. Of the three spectra which I had of the star one was made in 1926, one in 1930 and one in February of this year. Their radial velocities from about nine lines showed a range in the three plates of 15 km. and I had been somewhat uncertain whether to class the star as binary or of constant velocity.

In Hopmann's work he assigns a period of 2 hours and 22 minutes for the variability so the writer decided to take spectra continuously over the period. Five consecutive plates were made on the night of September 30, the exposure times being, roughly, half an hour. The radial velocities show only a range of 10 km. with an average of 18 lines measured on each plate. While minor differences in the spectra can be detected such could be set down to differences of exposure and development and there is not the slightest suggestion of a change in type from Bo to G2 as Hopmann suggested. Harvard gives the type as Ao; I would make it about A2.

---

*These Notes were intended for the issue of November last, but were continually crowded out.—*Editor.*

(2) The Spectroscopic Binary H.R. 8383

This star (1900, $R.A.=21^h\ 53.8$, $Decl.=+63°\ 09'$) visual magnitude 5.35, type Map was discovered to be a spectroscopic binary at the Lick Observatory in 1919. The writer has 32 plates scattered over the years 1922 to 1933. With the five Lick plates a long period was suggested but irregularities at the minimum of the curve seemed to indicate that some shorter period was the true one. W. H. Christie of Mt. Wilson, not knowing it was under investigation here, had also been working upon the star. In a communication, asking about some other measures, this star was mentioned and thus the duplication was discovered.

The results from the 12 Mt. Wilson plates seem to confirm the 20-year period which Christie had already felt was the true one. The results from the three observatories dovetail into each other nicely, a minimum of overlapping observations occurring. The binary bids fair to be a most interesting system. While it will be a year or so yet before the period can be determined at all accurately a value near to 7400 days is suggested. By adopting systematic corrections as used in Moore's catalogue it was possible to combine the observations and the following are offered as preliminary values of the elements on the basis of a 7400-day period: $e=.34$, $\gamma=-18.6$, $K=18.5$, $\omega=36°$, $T=J.D.\ 2,423,104$. The mass function suggested is large, 4.2. This is borne out by the absolute magnitude lines which suggest a star of high luminosity. The spectrum is rich in emission lines and there are suspicions of complexity in the absorption lines. Before inferior conjunction occurs in the spring of 1937 more will be learned of the system whose investigation is being undertaken now jointly by Christie and the writer.

(3) The Spectroscopic Orbit of H.R. 8584

The star H.R. 8584 (1900, $RA\ 22^h\ 27^m.0$, *Decl.*, $+29°\ 02'$) visual magnitude 6.32 and type A5 according to the Henry Draper classification was discovered to be a spectroscopic binary from the third spectrogram made here in 1928. Two earlier ones in 1926 showed no variation in velocity, both falling near the minimum of the curve, but the large negative velocity looked suspicious.

The spectrum is of the usual A5 type with numerous metallic lines in addition to the hydrogen series. While not sharp the lines are fairly well measurable, an average of 16 being measured on each of the 28 plates secured between 1926 and 1933. Some faint lines were at first thought to belong to the second component but later examination seemed to rule out the presence of the second spectrum on our plates. All plates were made with single prism dispersion and measured on the micrometer engine. The probable error of an average plate is ± 2.3 km. per sec. but, if three plates made on a shorter camera than usually employed are omitted, this reduces to ± 1.8 km. per sec.

The period was determined closely by joining up the early observations and so it was not included in the least squares solution. The final values from the solution are as follows:

Period	$P = 2.3409$ days.
Eccentricity	$e = .016$.
Longitude of apse	$\omega = 30°.1$.
Velocity of system	$\gamma = +1.73$ km./sec.
Semi-amplitude	$K = 79.18$ km./sec.
Periastron passage	$T =$ J.D. 2,424,715.985
a sin i	$= 2{,}548{,}500$ km.
Mass function	$= 0.121\ \odot$

METEOR NEWS

Observations relating to meteors and meteorites are cordially invited.

The Alberta Fireball of March 18, 1934

At about 8.40 p.m., M.S.T., on March 18, 1934, a detonating fireball of most unusual magnitude was observed over a large area in western Canada. Reports of this meteor have been received from an area bounded by Prince Albert and Regina, Sask., on the east and Helena, Mon., Nelson, B.C., and Edmonton, Alt., on the west. The direction of flight seems to have been from the east to the west over the central portions of the provinces of Saskatchewan and Alberta, the meteor exploding with a loud detonation over the region near Buffalo Lake, south of Camrose, Alt. The detonation was heard over a large area in towns separated by as great a distance as 150 miles. Estimates of the brightness of the meteor range all the way from that of a crescent moon to a radiance almost equal to the sun. This is the type of meteor from which meteorites might quite possibly be recovered, and one unconfirmed report of the finding of a meteorite has already appeared, but it is too early yet to give any definite information on this point.

This unusual meteor is under investigation at the University of Toronto and observations by eye-witnesses of the phenomenon are urgently desired. It will be greatly appreciated if readers of the Journal, who observed this fireball, or have friends who observed it, send their observations in to the Department of Astronomy, University of Toronto. The information to be given in reporting a fireball was summarized in Meteor News for February.

Observations of the 1933 Leonids—Part II

The observations of the Leonids made at the David Dunlap Observatory were reported last month. The following report deals with observations made by several smaller groups, most of them in or near Toronto.

Mr. Emerson W. Bullock organized and took charge of a station at Brampton, Ont., about twenty miles west of Toronto. A reticle

was used at this station as well as two direct cameras. Mr. J. M. Millman operated a meteor spectrograph in Saskatoon, Sask., as well as making visual observations. The complete personnel of all the groups follows:

Nov. 14-15

Group	1.	Brampton, Ont.:	E. W. Bullock, A. Giles, F. Hemphrey, R. Robinson, J. Young.
	2.	Saskatoon, Sask.:	J. M. Millman, D. S. Kirkbride.
	3.	Toronto (East):	H. E. Eby, H. D. Perrin.

Nov. 15-16

Group	4.	Brampton, Ont.:	E. W. Bullock, A. Giles, F. Hemphrey, R. Robinson, J. Young.
	5.	Saskatoon,Sask.:	J. M. Millman.
	6.	Huttonville, Ont.:	Howard Copeland, Philip Perry.
	7.	Dunlap Observatory:	Miss M. E. Gillespie.
	8.	Toronto (Central):	J. H. Millman, Mrs. J. H. Millman.
	9.	Toronto (East):	S. P. Hollingsworth, J. H. C. Warren
	10.	Toronto (East):	H. E. Eby, H. D. Perrin.
	11.	Toronto (East):	W. C. Macready, Miss G. D. Skilling.
	12.	Toronto (East):	W. J. Duncan.
	13.	Toronto (Central):	D. A. Carmichael
	14.	Toronto (North):	R. H. Scott, J. H. C. Vanderburgh.
	15.	Toronto (West):	Miss M. Mewhort.
	16.	Toronto (West):	Miss H. M. Crawford.
	17.	Toronto (Central):	Miss D. M. S. Champion.

Nov 16-17

Group	18.	Saskatoon, Sask.:	J. M. Millman, Mrs. R. M. Millman.

The observations were carried out with the same maps as were used at the Dunlap Observatory. The meteors were timed to the nearest second and where a group consisted of two persons, one observed while the other recorded. The numbers of meteors observed by each group are given in Table I, all times being E.S.T. except for groups 2, 5, and 18, where the time used is M.S.T. All but 12 of the meteors listed in Table I were plotted on the maps.

Though the material is not nearly as homogeneous as that from the Dunlap Observatory it is interesting to compute mean rates reduced to six observers. This was done, using the factors given last month, and the results appear in Table II. The high rates early in the morning of Nov. 15 arise from the relatively large

number of meteors observed in Saskatoon on that date. In the main, however, the rates agree with those found at the David Dunlap Observatory.

TABLE I

Group—	1		2		4		8		9		10		18	
Time	L	NL	L	NL	L	NL	L	NL	L	NL	L	NL	L	NL
12.10-12.30			2	3			1	4						
12.30-12.50			1	4			1	4						
12.50- 1.10			3	2			0	0						
1.10- 1.30	0	1	1	6	0	4	0	2						
1.30- 1.50	1	2	4	2	1	5	0	3						
1.50- 2.10	2	3	0	1	1	3	1	1					3	2
2.10- 2.30	2	5	1	4	4	4	2	3					2	5
2.30- 2.50	1	4	0	1	0	1	3	3					2	0
2.50- 3.10					3	7	3	3	0	1	1	1	2	2
3.10- 3.30					1	8			0	3	0	3	1	1
3.30- 3.50			0	1	1	3			4	1	0	3	2	2
3.50- 4.10			1	4	0	2			5	3	2	4	2	2
4.10- 4.30	0	5	5	3	0	1			5	5	4	2	2	1
4.30- 4.50	3	7	1	3					4	0	1	1		
4.50- 5.10	1	4	4	0					1	1	0	1		
5.10- 5.30	2	2	0	1										
Totals	12	33	23	35	11	38	11	23	19	14	8	15	16	15

Group	Observed	Leonids	Non-Leonids
2	1.15-1.45	0	2
5	2.30-4.30	7	5 clouds
6	3.50-4.35	5	1 haze
7	12.40-2.15	5	15
11	2.00-4.30	7	8
12	3.40-5.00	9	2
13	12.50-3.00	4	3
14	2.00-3.00	3	2
15	12.50-1.25	0	3
16	4.20-4.40	3	1
17	12.00-1.10	0	1

Total Leonids observed (L) 143.
Total non-Leonids observed (NL) 216. Total meteors observed 359.

TABLE II

Mean Hourly Rates Reduced to Six Observers

Time	1.00		2.00		3.00		4.00		5.00	
	L	NL	L	NL	L	NL	L	NL	L	NL
Nov. 14-15	20	40	15	25			24	33	20	25
15-16	4	22	11	21	13	20	24	22		
16-17					21	20	19	17		

A total of 101 meteors observed simultaneously from stations in at least two of the three localities, Toronto, Brampton and the David Dunlap Observatory, is itemized in Table III. Approximate heights can be computed for a fair percentage of these meteors. The magnitude distribution for 317 meteors observed on the three nights is given in Table IV. The mean magnitudes are very close to those of the Dunlap Observatory observations. For meteors down to the second magnitude $\frac{N_m*}{N_{m+1}}$ is 2.6 for the Leonids and 2.2 for the non-Leonids.

TABLE III

Meteors Observed at Two or More Stations

Nov. 14-15	16 meteors observed at	.....	D.D.O.	Brampton
	2 " " "	Toronto	D.D.O.	.....
Nov. 15-16	9 " " "	Toronto	D.D.O.	Brampton
	22 " " "	.....	D.D.O.	Brampton
	7 " " "	Toronto	.....	Brampton
	45 " " "	Toronto	D.D.O.	.....
Total	101			

TABLE IV

Magnitude Distribution of Meteors

Mag.	−1	0	1	2	3	4	5	6	Totals	Mean Mag.
Leonids.....	2	2	23	33	36	26	5		127	2.55
Non-Leonids.....	3	6	31	38	56	38	16	2	190	2.72

*N_m is the number of meteors of magnitude m.

A total of 6.8 hours exposure was made with the two direct cameras at Brampton and a second magnitude non-Leonid was photographed on Nov. 15-16, with a camera of focal ratio 1.25. The same meteor was also photographed at the Dunlap Observatory. The spectrograph at Saskatoon was exposed for a total of 9.0 hours on the three nights but no meteor spectra were obtained. Mr. R. D. Falconer made exposures with a Kodak F 4.5 quartz and sylvite lens at the Dunlap Observatory on Nov. 14-15 and photographed a meteor in a total exposure of about four hours. Mr. J. H. Day and Mr. T. R. Jones at the Dunlap Observatory and Mr. E. Gilbert and groups 10 and 14 in Toronto made exposures totalling about 15 hours with various types of cameras. No additional meteor photographs were secured.

In summary, the Leonid observations reported in these notes consist of some 1,875 individual observations of approximately 860 different meteors, 101 of these being simultaneously observed from two or more stations. Three meteors were photographed with direct cameras, one of these meteors being photographed from two stations.

The 1933 Leonid return was distinctly disappointing from a popular standpoint. Many thanks are due the observers mentioned above for their definite contribution to our knowledge of these meteors. Their enthusiasm in observing on extremely cold nights is to be highly commended.

P. M. M.

REVIEW OF PUBLICATIONS

The Infra-red Spectrum of the Sun from λ10000 to λ7600, by Dr. W. Baumann and Dr. R. Mecke. 56 pages, 7½ x 11 inches, with 6 plates. Johann Ambrosius Barth, Leipzig, price 12 R.M.

The extension of the region of spectral sensitivity of photographic plates in recent years has enabled spectroscopists to photograph the solar spectrum far into the infra-red. This region is particularly interesting because of the great number of lines of terrestrial origin found there. In 1928 the Mount Wilson Observatory in publishing a revision of Rowland's solar wave lengths included as an addendum an extension to the infra-red to λ 10, 218. Rowland's tables, published in 1895-98, stopped at the limit λ 7331.

The tables of Dr. Baumann and Dr. Mecke do not extend as far into the red as the Mount Wilson tables, but in the region intensively studied by them, namely λ 8800 to λ 7600, they are much more complete. The spectra were taken with a 6-meter grating giving a dispersion of 1.98 A. per mm. and a resolution of 10,000. The chief purpose of their research was an identification of the lines of terrestrial origin. On account of the low altitude of the sun at which the plates were taken (about 17½ degrees) these lines show very strong in the plates. In the revision of Rowland's wavelengths the lines of the atmosphere were not further identified. The authors' researches have enabled them definitely to ascribe all these lines either to water-vapour or oxygen. Molecular oxygen does not appear below λ 7600 nor are any of the lines to be ascribed to methane, ammonia or carbon dioxide.

R. K. Y.

NOTES AND QUERIES

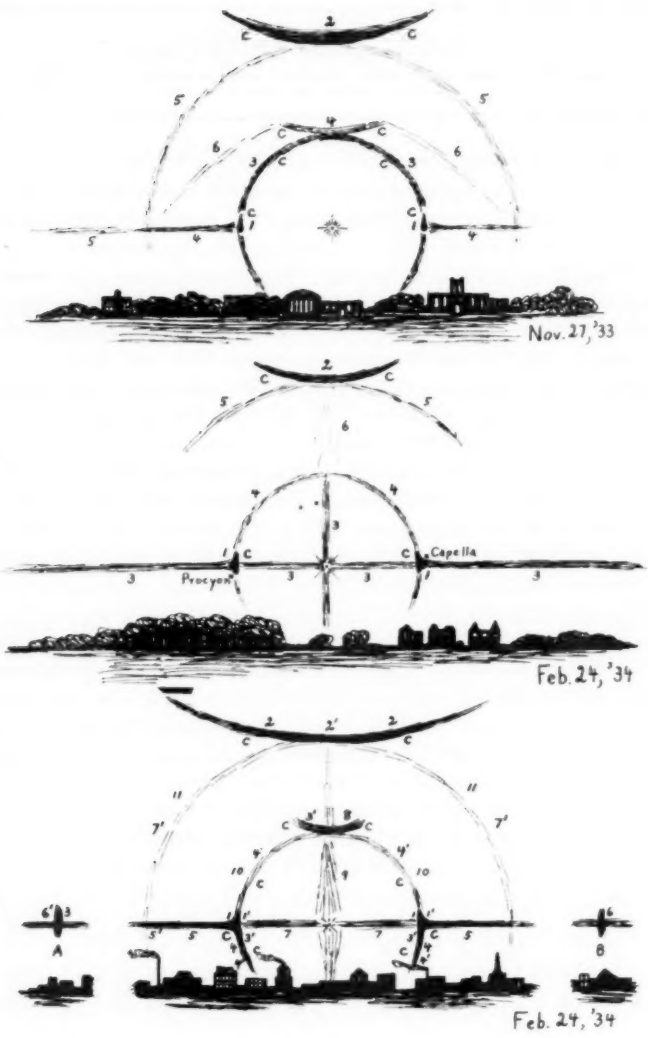
Communications are invited, especially from amateurs. The Editor will try to secure answers to queries.

SOLAR AND LUNAR HALOS.

In the accompanying figure are sketches of two halos about the sun and one about the moon, as drawn by Dr. P. M. Millman. Those of the sun were also observed by the present writer.

The first sketch (at the top) represents a solar halo observed from the front campus of the University of Toronto between 1.50 and 2.00 p.m. on November 27, 1933; the second, a lunar halo observed from North Toronto between 2.00 and 2.30 a.m. on February 24, 1934; the third, a solar halo observed from near the corner of Bloor and Bay Sts., Toronto, between 8.30 and 9.30 a.m., February 24, 1934. The temperature readings on these three occasions were 25°, 2°, and 0° F., respectively; the reduced pressures were 29.4, 29.7, and 29.8 inches. The inner circle, with centre at the sun or moon, was about 45° in diameter in each case; the outer circle, 90° in diameter. The numbers on the sketches indicate a purely qualitative scale of brightness for different parts of the halos, the brightest features being numbered 1. In the third halo the unprimed numbers refer to the appearance at 8.30 a.m., the primed numbers to the appearance at 9.30 a.m. In this halo the horizontal circle extended entirely around the horizon, the bright spots indicated at *A* and *B* appearing on it at distances of 120° from the sun. These same bright spots would probably have appeared in the case of the lunar halo had not light clouds and mist obscured the corresponding part of the sky. The parts of the halos lettered *C* exhibited prismatic colours. These were always strongest for the two dogs at 1 and the bow at 2. The red end of the spectrum was nearest the sun or moon in each case.

C.A.C.



TWO SOLAR HALOS AND A LUNAR HALO SEEN IN TORONTO.

MEETINGS OF THE SOCIETY

NOTE BY THE EDITOR

In the JOURNAL for October 1933 is a report of a lecture given to the Winnipeg Centre by Mr. S. E. McColl, Director of Surveys for Manitoba. In it was a paragraph from which it might be inferred that in South Africa and New Zealand the steel tape was not used in surveying. Mr. A. S. Walshe, Surveyor-General for New Zealand, has written to Mr. McColl stating that this inference is not correct. From a copy of his letter, supplied by Mr. McColl, the following information is quoted:

"The steel tape was, however, the invention of a New Zealand Surveyor, Mr. Edwin Fairburn, who certainly used it in 1871 and possibly earlier. Its use very rapidly spread among the surveying profession here, and we have numerous records of its use in 1873 by other surveyors, and by the late 'eighties it was practically universal in its present form—long bands 5 to 10 chains in length and from one-eighth to one-sixteenth inch in width. The properties of the catenary curve in its application to surveying were investigated by Mr. C. W. Adams (a New Zealand surveyor) and Mr. Arthur Beverly, both of Dunedin, and tables of sag factors calculated. A paper embodying these was read before the Victorian Institute on the 1st September, 1888, and this paper was subsequently printed by my Department as a Professional Paper.

Long piano wire measures threatened to displace it at one period, but this material seemed to possess a stubborn tendency when not under tension to resume the original coil so that if the uphill end were loosened the Surveyor would find the whole length at the bottom in loose interwoven coils necessitating much trouble and bad language in getting it once more nicely coiled on its drum.

Invar was substituted for steel for special purposes such as baseline measurements in 1906, and at the present time is coming into almost universal use for ordinary land title surveying."

AT TORONTO

November, 21, 1933.—The regular meeting was held at 8 p.m., Mr. R. A Gray in the chair.

Mr. Fred Graham, 232 Winona Drive, Toronto, was elected a member. The Chairman then named the following as a committee to nominate officers for Toronto Section for 1934:—Mr. J. R. Collins (chairman), Prof. R. K. Young, Mr. J. H. Horning, and Mr. E. J. A. Kennedy.

The lecture for the evening was on "The Harvard Observatory, Past and

Present" by Dr. Peter M. Millman. The Harvard Observatory for nearly 100 years has been a pioneer in astronomical research. There are associated with it many names of men and women whose labours have helped to enlighten the world. Massachusetts Bay Colony was founded in 1607 and Harvard University in 1636. The University soon took an interest in astronomy, sen an expedition to Newfoundland in 1812, and was able to erect an observatory in 1839. In 1846 funds were secured for a new building, and a 15-inch refractor. This telescope, one of the largest at that time, is still in use at Cambridge. Dr. Millman outlined the work of the observatory for each decade. The first photographs of the moon were taken in 1840, and ten years later Vega was photographed for the first time. Dr. William Cranch Bond, the first director of the observatory, was the first person in the new world to receive the gold medal of the Royal Astronomical Society. In 1876 Edward C. Pickering became director. He introduced continual night photography of the heavens. Two other observing stations were established, one in Peru, which remained until 1928, and another at Mount Wilson, which was used only two years. The photographic plates accumulated in such numbers that in 1901 a building was erected to store them. Two meteorological stations were started, one in Peru, and the other at Blue Hill. Dr. Harlow Shapley was appointed director in 1921, and durin; the next decade much new equipment was added to the observatory, including twelve telescopes. The air at Cambridge was now poor for observation of the stars because of the smoke, and it was decided to move the observatory to Oak Ridge, 26 miles distant. For this station a 61-inch reflector was ordered, and it is now nearly completed. The observatory in Peru was moved to Bloemfontein, South Africa, including a new 60-inch telescope. Thus Harvard Observatory has now two large telescopes, one in the northern hemisphere and one in the southern. A new building had to be constructed to keep the half million plates which show a continuous sky record since 1885. When Pluto was discovered the plates were searched for its image, which was recorded for 16 years back. Thus the orbit of the planet could be computed roughly without delay.

In concluding, Dr. Millman explained how the observatory has had great success in interesting the public in astronomy.

Following the lecture, Mr. E. J. A. Kennedy gave a concise and interesting account of the planet Venus.

G. HEPBURN, *Recorder*.

AT VICTORIA

October 6, 1933.—After the usual business the following were elected to membership in the Society:

Mrs. P. W. Rawson, Mr. J. R. Butler, both of Victoria.

G. Browne-Cave gave a 5-minute talk on "Mass and Weight". The mass of a body is the quantity of matter in it, its weight depends on the mutual gravitational attraction between its mass and that of another body (the earth). Weight varies inversely as the square of the distance between the bodies. Mass is independent of the existence of any other body.

Dr. J. A. Pearce announced the winners of the essay contests on the lectures given during the summer course as follows Basil Ford, W. F. Holdridge, Gordon Shaw.

The president then introduced Mr. Charles Hartley, M.A., who spoke on "Two Great Astronomers, Tycho Brahe and Kepler". [Prefacing his remarks by the statement that for over a thousand years the world had been mesmerised by Ptolemy's system of the universe, Mr. Hartley briefly sketched the development of astronomical thought from the earliest times until Copernicus broke the spell with his book "De Revolutionibus Orbium Coelestium" in 1543.

The great observational work of Tycho Brahe was undertaken largely to disprove Copernicus' theory. Kepler, who became Tycho's assistant in 1600, deduced from these observations, after many years of poverty and ill health, his three great laws of planetary motion:

I. Published in 1609—The orbits of the planets are ellipses with the sun at a focus.

II. Published in 1604—The radius vector between the sun and a planet sweeps out equal areas in equal times.

III. Published in 1619—The squares of the periodic times of the planets are proportional to the cubes of their mean distances from the sun.]

The lecture was most happily conceived and gave a vivid picture of the life and times, habits and peculiarities of these two great men.

Following a short discussion the meeting terminated.

H. Boyd Brydon, *Secretary-Treasurer.*

AT WINNIPEG

October 11, 1933.—The opening meeting of the season was held in the old Science Building of the University; Mr. A. W. Megget, president, in the chair.

The speaker for the evening was Dr. L. A. H. Warren, and his subject, "Fundamentals of Astronomy". Dr. Warren gave a brief summary of the mapping of the heavens into groups—the constellations—by the ancients. As far back as history goes, we find the same names of many of the constellations. In the time of Ptolemy, 48 were outlined and well defined. It is probable that this charting was done somewhere about Asia Minor. The southern skies, not being visible there, remained uncharted until comparatively moden times. The magnitude of the stars was considered, under apparent surface area, distance, temperature, colour, or physical conditions; also the manner of naming them in the constellation, using the Greek and Latin alphabets and then numerals. Units of sidereal measurements were noted, such as the distance from the earth to the sun, the light year and the parsec, a new term equivalent to 3.26 light years.

The lecturer then directed attention to our own Solar System, defining the meaning of the *conjunction* of the inferior planets—between the earth and

sun—the *opposition*, *elongation* and *quadrature* of the superior or outer planets. He also explained how it is that Venus is sometimes an evening and at other times, a morning star. The lecture was well illustrated with lantern slides.

J. C. Howey, *Recorder*.

AT VANCOUVER

December 12, 1933.—The meeting was held at the University of British Columbia.

During the first part of the meeting the President, Mr. J. Teasdale, was in the chair. The minutes of the last meeting were read and adopted.

As it was the Annual Meeting of the Centre the reports of the different officers were read and adopted. The election ballots were then counted, and the following officers were declared elected for 1934:

Hon. President—Dean D. Buchanan
President—William Ure
First Vice-President—J. L. Bennett
Second Vice-President—F. R. Williams
Treasurer—C. A. Macdonald
Recording Secretary—Walter H. Gage

Members of Council:

H. C. B. Forsyth
H. P. Newton
N. H. Hawkins
J. A. Mackenzie
Mrs. C. M. Robson
M. A. McGrath
A. Outram
H. A. Pitman
S. A. Richmond
G. M. Shrum
J. Teasdale (Retiring President)

During the counting of the ballots, the meeting was thrown open for discussion. In particular, two questions were raised: (1) the advisability of establishing junior membership for University students; (2) revision of the election system.

Mr. Teasdale, the retiring president, expressed his thanks to the retiring executive and welcomed the new officers. The new president, William Ure, then took the chair.

The programme for the evening was in the form of a debate: "Resolved that life may exist extensively in the Universe."

Mr. Bennett, opening for the affirmative, pointed out that living things, both in the plant and animal kingdoms, are susceptible to their environment, and quoted Sir J. Arthur Thomson on the defying quality of life, and its insistence and insurgence. He enumerated the conditions for growth on the earth but showed that there was ample evidence of conditions as nobly planned in other worlds as in ours.

Mr. Macdonald, the second speaker, criticized his opponent's views concerning the probabilities of life under the more extreme physical conditions.

He made a very extensive analysis of conditions on members of the Solar System other than the earth, and stated that life was not necessarily an important part in the plan of things, in fact, in the history of the cosmos, life played a relatively unimportant part.

Mr. Pollock, for the affirmative, reviewed the arguments of his colleague, and very cleverly amplified them by means of commonplace illustrations. Life, he stated, must not be considered in terms of one individual, but rather in terms of geological life over 2,000,000,000 years. With this point of view, life played an extremely important part.

Mr. Williams, the final speaker, referred extensively to Jeans' chapter on "Life in the Universe". A planetary system was in all probability an accident, caused by the close approach of two stars, and the chance of such an approach was extremely small. He pointed out that our ideas of life elsewhere rested on pure assumption, without a shadow of direct or concrete evidence.

After the rebuttal by the leader of the affirmative, the audience, acting as judges, awarded the decision to the affirmative.

Following a short discussion, the meeting adjourned.

January 9, 1934.—The twenty-first regular meeting was held at 8.15 p.m. The president, Dr. William Ure, presided.

Among the audience were members of the Mathematics Club of the University of British Columbia.

The president asked Mr. Paul Sykes to outline for the coming month the constellations and stars in favourable position for observation. Mr. Sykes gave an excellent and instructive summary.

The principal address of the evening was given by Professor Walter H. Gage, of the University of British Columbia, on the subject "Variable Stars".

In the first part of his address, the speaker gave an outline of the discoveries of some of the more famous stars whose brightness had fluctuated, including Hipparchus' Star, Tycho's Star, Mira Ceti, Algol and Nova Persei. He described the various methods of cataloguing variable stars and of determining their magnitudes, and discussed in some detail the construction of light curves.

On the basis of the light curves, explained the speaker, variable stars can be divided into two classes; first, periodic variables, and second, non-periodic variables. Periodic variables can be further subdivided into eclipsing binaries, short-period or Cepheid variables, and long-period variables. Non-periodic variables are either novae or irregular. The differences in the light curves of these five types were shown by means of lantern slides.

The speaker then briefly sketched the theories of light and of spectrum analysis and pointed out that the stars can be classified according to their spectra into a comparatively small number of groups. He described the attempts of Lockyer, Russell, Eddington and others to fit all the known facts into a satisfactory theory of evolution, and referred to Eddington's mass-luminosity law.

Professor Gage then applied spectrum analysis to the five types of variables. He showed how the fluctuations in magnitude of Algol were caused by eclipses

in double star systems and described Jean's theory of fission which may account for binary systems. The most satisfactory explanation at the present time for Cepheid variables is the pulsation theory, suggested by Shapley and worked out by Eddington. The audience learned how Cepheids of the cluster type can be used as distance indicators, and how these stars give no evidence of other universes similar to our own. So far, stated the speaker, the known facts for long-period and irregular variables and for novae have not been satisfactorily correlated. Eddington explains the first two types by his pulsation theory, but the spectra of these stars introduce many puzzling features. In the same way, the spectral changes in the novae have as yet defied investigators, although some form of collision or passage through nebulous material is suggested.

Dean Buchanan expressed his appreciation of the lecture. After several questions by members of the audience, Mr. Andrew Guthrie, president of the Mathematics Club of the University of British Columbia, conveyed the thanks of his fellow members for the invitation to the address.

WALTER H. GAGE, *Secretary.*

AT LONDON

November, 1933.—Mr. T. C. Benson gave two very interesting and helpful demonstrations. The first was that of a constellation and star finder he had made for a boys' camp the previous summer.

I am indebted to Mr. Benson for his help in the description of this clever device.

A triangular wooden base, fitted with levelling screws, had mounted upon it a ⅜-inch brass rod, adjustable to any angle in relation to the base, so that when adjusted to the angle corresponding to the latitude of the point of observation, and so orientated that the rod points to the North Star it will parallel the earth's axis.

Mounted rigid near the top end of, and with its plane at right angles to the rod, is a semi-circular disc with hour scale divided from three p.m. to three a.m. In front of the above disc, or below it on the rod, is a slightly smaller circular disc with scale on outer edge divided into twelve months, and sub-divided into the days of the months. This disc is movable so that the day of observation can be placed opposite the hour of observation as marked on a semi-circular rigid disc. All first magnitude stars and main constellations are printed on the movable circular disc, the names being printed radially in the correct position in relation to the monthly and daily scale, and after each object its declination in degrees.

Mounted in front of this circular disc, or still below it on the main rod, is mounted with a T fitting another rod at right angles to the first and adjustable around it. This rod has a fixed brass wire pointer toward the star and constellation scale. Fastened near the top of this rod is a semi-circular disc with its back surface fastened rigidly to rod and parallel to the earth's axis rod. It carries a declination scale from $-30°$ to $+90°$ and on

through the north point to +60°, the 0° line resting opposite the centre line of rod on which disc is mounted. Fixed on the top end of this rod, which may be called appropriately the Right Ascension rod, is a 90° elbow and nipple on which a third rod may be made to revolve in a vertical plane. This rod carries a brass wire pointer pointing toward the declination scale and can be fastened by thumb screws in any desired position.

To operate it it is necessary to be able first of all to identify the North Star. Point the earth's axis rod (which carries two sights for this purpose) to the North Star, then place the date of observation on the hour of observation. Adjust the right ascension rod so that the pointer points to the object desired on the disc, note the angle of declination marked on this scale for this object. Adjust third rod so that the pointer points to this angle on declination scale and this rod is now pointing to the desired object in the sky.

The purpose of the second demonstration was to show the theory and use of Foucault's pendulum. Mr. Benson spoke of the pendulum as the most perfect measurer of time.

The three laws governing the vibrations were illustrated by balls of different weights suspended from a metal arm at similar and varying lengths.

A large rubber ball represented the earth and the vibration paths of a pendulum were shown to cover a complete circle at the poles in a period of 24 hours, while at the equator the plane of the vibrations moved forward with the motion of the earth and a single straight line was produced.

A vote of thanks to the speaker was heartily approved by the members.

January 12, 1934.—The meeting was held in the London Life Building, Mr. Gunn the president being in the chair. There were 24 members present.

The following were elected members:

Miss E. B. Howie, 387 William St., London

Miss Rena Turner, 567 Maitland St., London

Dr. H. S. Wismer spoke on the subject "Fragments of Astronomical Bodies". He defined a meteorite as a meteor come to earth. Many of the latter are so small as to be entirely consumed as they pass through our atmosphere and only the ashes come to earth.

The speaker showed specimens of stone and of metallic meteorites—a very heavy one composed of iron and nickel found in Mexico. This had been polished and etched on one side to show the lines considered to be a proof of the meteoric origin of such masses of metals. Pictures were projected on the wall showing the results of the falling of some of the larger meteorites and the speaker remarked on the little destruction these have caused considering their great size and weight, the one which fell in Africa being estimated to weigh 50 tons. Some fine specimens of fossils were shown also and other stones of geological interest.

Dr. Kingston spoke on "Calendar Reform". He showed the difficulties of fitting the natural divisions of time—the day, the month, the year, into each other, so as not to cause the date to slip gradually into a part of the year it does not represent. He showed the losses to the business world caused by the great

difference in the time of Easter recurrence according to our present calendar, and the confusion caused by the variety in the numbers of working days in the different months.

Illustrations were shown of the two proposed calendars. The first, sponsored by the World's Calendar Association, has 26 working days in each month. The second, commonly known as the Thirteen-month Calendar, with the month Sol coming in mid-summer, meets with most opposition from the public. The fact however was stated that this division of time is already used by 400 companies in the United States as well as by some few in England.

N. MORRIS, *Secretary-Treasurer.*

AT HAMILTON

October 10, 1933.—The meeting was held in the lecture hall of the Public Library at 8.15 p.m. Mr. W. S. Mallory presided.

The evening was devoted to a series of brief addresses by various members of the Society regarding personal observations made during the past summer months.

Dr. William Findlay reported on his observations of the conjunction of Venus and Jupiter. Mr. T. H. Wingham during his many observations of the heavens located a "misty spot" which, on reference to Ottawa, proved to be Brooks' comet. Mr. J. S. Taylor of Richwood told of his observations on the moon. Rev. E. F. Maunsell of Beamsville explained the construction of his hand-made reflector and paid a debt of gratitude to the late Dr. Marsh who had materially assisted in its construction. He also described the many interesting sights he had viewed in the heavens. Dr. Bell of Paris reported on the conjunctions of planets and on sun-spots. Mr. W. S. Mallory told of his observations and the making of photographic slides of the conjunctions. Mr. J. A. Marsh gave a short talk on the sky for October and explained the position of the outstanding planets and stars to be seen in the heavens.

Mr. Mallory closed the meeting by paying a tribute to the memory of the late Dr. D. B. Marsh, Honorary President of this Centre as follows. As a token of respect the members stood in silence for a brief space of time.

We cannot let go this opportunity of paying a tribute to the late Dr. Marsh. His passing is so recent that we have not fully realized that he will no longer be with us to instruct us (in his own delightful manner) in the mysteries and beauties of astronomy nor entertain us with his kindly humour. Much has been written and said about his accomplishments in the realm of astronomy and mechanics and I do not purpose to repeat these now as they are familiar to you all. His interest in astronomy remained keen almost to the last.

All his life he not only pushed his own knowledge as far as he could but he was always encouraging others to look up above the things of this world, an idea he seems to have gained from his mother. His helping hand was evidenced in the number of branches of the R.A.S.C. which he assisted in forming and continued to nurture and in many individuals he truly interested in astronomical work. Any inquirer might ask for his aid in explaining the heavens or ask advice

about the making or use of any astronomical instrument and that enquirer always received the aid he asked.

As Dr. Marsh became weaker and weaker through the spring and summer he still had a burning desire to see others continue his work. He wanted his instruments to be in use. For this reason he encouraged some of us to carry on observations and photographic work already mentioned. He had us looking for sunspots. A new comet appeared last June and he had us searching for it. He directed and also did some of the work of mounting Mr. Maunsell's telescope.

About two and a half weeks before he died he gave me a message for this Centre. He was very weak. He kept his eyes closed while he held my hand and laboured to tell me his message. Often pausing to get control of his breath and his feelings. He said, "Tell the Centre here I thank them for their interest in me. Thank you for what you have done. Tell them that my study of astronomy has made me believe all the more in Divine Grace. I believe God rules the universe, that He wants to dwell in the hearts of men, that man sinned and fell and that man may have salvation through the sacrifice of his Son. I want that to be my testimony.

Just as the stars move in their course according to some great law of order; just as the planets revolve about the sun, so that Kepler when he discovered their orbits said 'I have thought God's thoughts after him'; just as the comets come into close proximity to the sun with a rush of glory and flee away to disappear for years and sometimes forever, so the souls of men come to us out of the everywhere into the here and pass on again according to some mysterious law we but faintly understand." Dr. Marsh, like the comet, seems to have swept before us, shedding a glory that blessed many men and passed on into God's vast spaces, but the glory of his sojourn will not fade with the present generation. Let us remember that the same order that guides the swirling heavens must guide the destinies of man and, though we cannot understand all, we can at least trust our destinies to the One to whom Dr. Marsh wished to pay his final tribute.

November 14, 1933.—The meeting was held in the lecture hall of the Public Library at 8.15 p.m. with Mr. W. S. Mallory president, in the chair.

Mr. Norman Green was elected a member of the Society.

Mr. J. A. Marsh gave a brief talk on the sky for November. He spoke particularly about the brilliance of Venus and Mercury, the nebula in Pegasus, and the meteor showers to be seen in the sky.

The speaker of the evening, Professor A. E. Johns, spoke on the subject "Time". He began by contrasting Newton's objective and Kant's subjective definitions of time with Einstein's space-time concept. He pointed out the difficulties of arriving at a common-sense definition of time, *e.g.*, What was "now" on a star? The development of time-measuring apparatus was rapidly traced. Time meant for us the rotation of the earth, but this was not strictly uniform because of the earth's shrinkage and the tides. He referred humorously to the measurement of time in Western China, and demonstrated the inaccuracy of

the sun as a time-keeper. With the help of slides he proceeded to show why sun time was inaccurate. Sidereal time was more accurate and some of the apparatus used in its calculation, including a watch invented by the late Dr. Marsh, were described. Professor Johns spoke of the detail necessary in the calculation of sidereal time. He traced the relation between solar, sidereal, and standard time: this last one was invented by a Canadian, Sandford Fleming.

Some problems arising from the international date line were amusingly dealt with and the advantages of a revised calendar pointed out. The lecturer described an interesting method of his own for calculating the time from the pole star.

December 11, 1933.—The meeting was held in the lecture hall of the Public Library at 8.15 p.m.

The following nominations for 1934 prepared by the Council were approved:
Hon. President—Mrs. C. Marsh
President—Professor Wm. Findlay
Vice-Presidents—Professor A. E. Johns, T. H. Wingham, and W. T. Goddard
Secretary—S. W. Scammell
Treasurer—G. E. Campbell
Curator—T. H. Wingham
Council—Dr. G. M. Jackson, W. G. Milne, Mrs. S. W. Scammell, J. A. Marsh, Rev. John Samuel, T. D. Waring, W. S. Mallory, Rev. E. F. Maunsell, J. A. Little, J. S. Taylor

Mr. Mallory, the president, introduced the speaker of the evening, Mr. J. R. Collins, a past president of the R.A.S.C. The subject of his lecture was "Our Earth Among the Stars". By means of lantern slides from photographs and diagrams, Mr. Collins showed the position of the earth in the solar system and described minutely the various planets and their satellites. Particular reference was made to the sun and to the effects of sun-spots on the earth. The lecturer then took his audience beyond the solar system and explained the position and character of some of the larger stars to be seen in the heavens during December and how these could readily be located by the amateur observer.

The many questions asked of the speaker and answered satisfactorily by him displayed the keen interest of the members and a very hearty vote of thanks was accorded him at the close of the address.

The new president of the centre, Professor Wm. Findlay, was introduced to the meeting by Mr. W. S. Mallory and was accorded a hearty reception by all present.

Notice to Members of Victoria Centre.—For the purpose of compiling a complete new catalogue of the library all members having books in their possession, the property of the Centre, are particularly requested to notify the Secretary at once. Phone: Garden 7187. Your co-operation will be much appreciated.

H.E.M.

The Royal Astronomical Society of Canada

OFFICERS FOR 1934

Honorary President—Mgr. C. P. Choquette, M.A., Lic.Scs., Montreal.
President—Lachlan Gilchrist, M.A., Ph.D., Toronto.
First Vice-President—R. E. DeLury, M.A., Ph.D., Ottawa.
Second Vice-President—J. A. Pearce, M.A., Ph.D., Victoria.
General Secretary—R. A. Gray, B.A., 198 College St., Toronto.
General Treasurer—J. H. Horning, M.A., 198 College St., Toronto.
Recorder—E. J. A. Kennedy, Toronto.
Librarian—R. A. Gray, B.A., Toronto.
Curator—R. S. Duncan, Toronto.
Council—D. S. Ainslie, M.A., Ph.D., Toronto; F. Napier Denison, Victoria, B.C.; Miss A. Vibert Douglas, Ph.D., Montreal; Wm. Findlay, Ph.D., Hamilton, Ont.; E. A. Hodgson, M.A., Ottawa; A. R. Hassard, K.C., Toronto; E. H. McKone, B.A., B.Paed., London, Ont.; J. Patterson, M.A., Toronto; John Satterly, M.A., D.Sc., Toronto; L. A. H. Warren, M.A., Ph.D., Winnipeg; and Past Presidents—Sir Frederic Stupart; C. A. Chant, M.A., Ph.D.; A. T. DeLury, M.A.; L. B. Stewart, D.T.S.; J. S. Plaskett, D.Sc., F.R.S.; A. F. Miller; J. R. Collins; W. E. W. Jackson, M.A.; R. M. Stewart, M.A.; A. F. Hunter, M.A.; W. E. Harper, M.A.; H. R. Kingston, M.A., Ph.D.; R. K. Young, M.A., Ph.D.; and the presiding Officer of each Centre as follows—R. Glenn Madill, B.A., Ottawa; G. Harper Hall, Montreal; D. R. P. Coats, Winnipeg; H. Boyd Brydon, Victoria; George Gunn, London, Ont.; Prof. Wm. Findlay, Hamilton, Ont.; William Ure, Vancouver; M. J. Hilton, Edmonton.

TORONTO CENTRE

Honorary President—Sir Frederic Stupart
Chairman—R. A. Gray, B.A.
Vice-Chairman—A. R. Hassard, K.C.
Secretary—E. J. A. Kennedy
Curator—R. S. Duncan
Recorder—H. F. Balmer, M.A.
Assistant Curator—F. L. Troyer
Observation Committee—Dr. C. A. Chant; A. R. Hassard, K.C.; J. R. Collins; Dr. P. M. Millman; J. H. Mallory.

OTTAWA CENTRE

Honorary President—J. S. Lane, B.A.
President—R. Glenn Madill, B.A.
First Vice-President—A. H. Miller, M.A.
Treasurer—A. W. Grant, B.A.
Second Vice-President—John McLeish, B.A.
Secretary—Malcolm M. Thomson, B.A., Dominion Observatory, Ottawa
Council—Dr. A. Willard Turner; Dr. E. A. Hodgson; C. A. French, B.A.; J. P. Henderson, M.A.; Miriam S. Burland, B.A.; R. Meldrum Stewart, M.A.; Dr. R. E. DeLury; Dr. R. J. McDiarmid; C. R. Coutlee, C.E.; C. C. Smith, B.A.

MONTREAL CENTRE

Honorary President—Mgr. C. P. Choquette
President—Geo. Harper Hall
First Vice-President—Dr. D. A. Murray
Second Vice-President—Dr. Julian Smith
Secretary-Treasurer—Dr. A. Vibert Douglas
Council—Dr. A. S. Eve; Dr. L. V. King; Mr. Justice E. E. Howard; Lt.-Col. W. E. Lyman; Dr. A. H. McCordick; Prof. N. B. McLean; Dr. W. D. Lighthall; O. A. Ferrier

LONDON CENTRE

Honorary President—H. R. Kingston, M.A., Ph.D.
President—George Gunn
Vice-President—Major E. H. Anundson
Secretary-Treasurer—Miss N. Morris, 103 Elmwood Ave., London, Ont.
Council—Mrs. W. P. Burns; S. J. Versteeg; Dr. H. S. Wismer; Mrs. S. G. Hungerford; J. Middlebrook.

WINNIPEG CENTRE

Honorary President—J. S. Plaskett, D.Sc.
President—D. R. P. Coats
First Vice-President—L. T. S. Norris-Elye
Second Vice-President—James Houston
Treasurer—J. H. Kolb
Secretary—Mrs. J. Norris, 569 Sherburn St., Winnipeg
Recorder—Mrs. J. C. Howey
Council—A. W. Megget; C. E. Bastin; A. R. McCauley; Dr. N. J. McLean; A. V. Pigott; F. Pugh; Mrs. E. L. Taylor; Dr. L. A. H. Warren

VICTORIA CENTRE

Honorary President—James Duff, M.A.
President—H. Boyd Brydon
First Vice-President—Charles Hartley, M.A.
Second Vice-President—F. S. Hogg, Ph.D.
Secretary—H. E. Moore, M.A., Hotel Metropolis, Victoria, B.C.
Council—G. Browne-Cave; W. Burton; T. J. Greenway, F.I.C.; W. R. Hobday; W. F. Holdridge; Lt.-Comm. R. H. Tingley, R.C.N.

HAMILTON CENTRE

Honorary President—Mrs. C. Marsh
President—Prof. Wm. Findlay
Vice-Presidents—Prof. A. E. Johns; T. H. Wingham; W. T. Goddard.
Secretary—S. W. Scammell, 121 Eastbourne Ave. S., Hamilton, Ont.
Treasurer—G. E. Campbell
Curator—T. H. Wingham
Council—Dr. G. M. Jackson; W. G. Milne; Mrs. S. W. Scammell; J. A. Marsh; Rev. John Samuel; T. D. Waring; W. S. Mallory; Rev. E. F. Maunsell; J. A. Little; J. S. Taylor

VANCOUVER CENTRE

Honorary President—Dean D. Buchanan
President—William Ure
First Vice-President—J. L. Bennett
Treasurer—C. A. Macdonald
Second Vice-President—F. R. Williams
Recording Secretary—Walter H. Gage
Council—H. C. B. Forsyth; H. P. Newton; N. H. Hawkins; J. A. Mackenzie; Mrs. C. M. Robson; M. A. McGrath; A. Outram; H. A. Pitman; S. A. Richmond; G. M. Shrum; J. Teasdale (Retiring President).

EDMONTON CENTRE

Honorary President—Dr. J. W. Campbell
President—M. J. Hilton
Vice-President—Dr. E. H. Gowan
Treasurer—W. H. Poole
Secretary—H. H. Beach, University of Alberta, Edmonton
Council—Mrs. J. A. Clarke; W. O. Coulman; T. W. Hamilton; A. B. McKim; Prof. E. S. Keeping.

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

This Society was incorporated in 1890 under the name of The Astronomical and Physical Society of Toronto, and assumed its present name in 1903.

The Society has active Centres in Montreal, P.Q.; Ottawa, Toronto, Hamilton, and London, Ont.; Winnipeg, Man.; Edmonton, Alta.; Vancouver and Victoria, B.C.

The Society publishes a monthly JOURNAL containing each year about 500 pages and a yearly OBSERVER'S HANDBOOK of about 80 pages. Single copies of JOURNAL or HANDBOOK are 25 cents.

Membership is open to anyone interested in astronomy. Annual dues, $2.00; life membership, $25.00. Publications are free to members, or may be subscribed for separately. Apply to the General Secretary, 198 College St., Toronto, or to the local secretary of a Centre.

Extract from the By-Laws: Candidates who are elected to membership will be attached to a particular Centre, or to a section known as *Members at Large*. Members of the Society who live outside of Canada, or in a province in which there is no Centre of the Society will be considered *Members at Large* and not attached to any particular Centre, unless these members are expressly nominated for membership and attachment to a particular Centre. Members may be transferred from one Centre to another, or to the section *Members at Large* by the Council of the Society if written application for such transfer is made by such member to the Council.

The Society has for Sale:

General Index to the TRANSACTIONS of the R.A.S.C., 1890-1905, and the JOURNAL, Vols. 1 to 25, 1907-31.

Compiled by W. E. Harper, Assistant Director, Dominion Astrophysical Observatory, Victoria, B.C.

Pages, 122; Price, $1.00, postage 5c. extra.

New Materials for the History of Man—The Festival of the Dead, by R. G. Haliburton.

This is a research into the Year of the Pleiades, first published at Halifax N.S., in 1863; reprinted by the R.A.S.C. in 1920.

Pages, 126; Price, $1.00, postage 5c. extra.

Send Money Order to 198 College St., Toronto.